BOC

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# Furnace brazing

Although a great deal of brazing is done either by hand or by machine in the open air, this profile focuses solely on furnace brazing using a controlled atmosphere.

## What is Brazing?

Brazing is a joining technique for metals or ceramics using a metal with a lower melting point than either of the materials to be joined to make the joint. Technically, only processes using a metal that melts above 450oC are brazing; below that is soldering. In furnace brazing the whole assembly is heated to a temperature where the braze alloy melts and flows into the joint. On subsequent cooling it freezes making a solid joint. In furnace brazing operations many thousands of joints can be made at the same time.

Figure 1. Copper brazed steel bowl

## What can be brazed?

Almost any metal or ceramic can be brazed. As long as the braze alloy "wets" both the surfaces to be joined there will be a bond formed. To get wetting of metals there must be no oxide on the surfaces. When brazing in air a flux is used to remove the oxide, but in furnace brazing it is usually removed by the atmosphere. For most atmospheric pressure processes it is hydrogen that does the reduction, but in vacuum brazing it is the vacuum itself that decomposes the oxide. For ceramics and some metals getting wetting is more difficult and a reactive braze alloy is needed that either dissolves or reacts with the surface. The wetting of the copper used to braze the steel bowl in Figure 1 can clearly be seen around the joints.

Figure 2. Copper brazed mild steel select lever assembly

## How is it done?

This is a very broad question with many answers depending on what is being brazed and in what type of furnace. It is probably best answered by giving some examples.

### Copper brazed mild steel processed in a mesh belt furnace

The first example is the select lever assembly shown in Figure 2. This mild steel assembly is brazed using a copper paste at three different joints in an endothermically generated atmosphere (approximately 20% carbon monoxide, 40% hydrogen and 40% nitrogen). A mesh belt furnace is simply a long box. The front part is heated and the back part water cooled. The parts are conveyed through the furnace on a wire mesh belt like that below the parts in Figure 2.

There are big variations in cross sectional area so that this part would be difficult to process in a single zone furnace. A three-zone furnace, with the first two zones set below the melting point of the copper to act as a pre-heat is therefore used. The parts then enter the third zone, which is only 10-15°C above the melting point of copper. This means the time at final temperature is minimised giving excellent control over the flow of the copper which is pulled into the joint by capillary action when it melts. The parts then cool slowly as they pass through the water cooled section of the furnace.

### Silver brazed copper processed in a vacuum furnace

A copper assembly for a defence application is shown in Figure 3. The assembly is being temporarily held together with its oxidised stainless steel jig for the brazing operation. A copper/silver alloy in the form of a foil has been placed in the joint. Although this is a small part being vacuum brazed to minimize the risk of movement during the processing, vacuum brazing is more typically used for large complex assemblies that could not be brazed in other types of furnace.

### Aluminium heat exchanger brazed in a mesh belt furnace

This example has been chosen simply because it is so common. It is used to make the heat exchanger cores of automotive radiators and oil coolers and both automotive and domestic air conditioners. Although it is common, it is unique in terms of furnace brazing. Instead of trying to place the brazing alloy in or near every joint, it is roll-bonded onto the thin aluminium sheet that forms the webs between the tubes so it is present at every joint. As aluminium oxide is virtually impossible to reduce, a flux is used. The flux, which is very aggressive at brazing temperature, but passive at room temperature, needs to be protected from oxygen and water vapour so a dry nitrogen atmosphere is used.

Some examples of good and bad joints are shown in Figure 4 and a typical furnace in Figure 5.

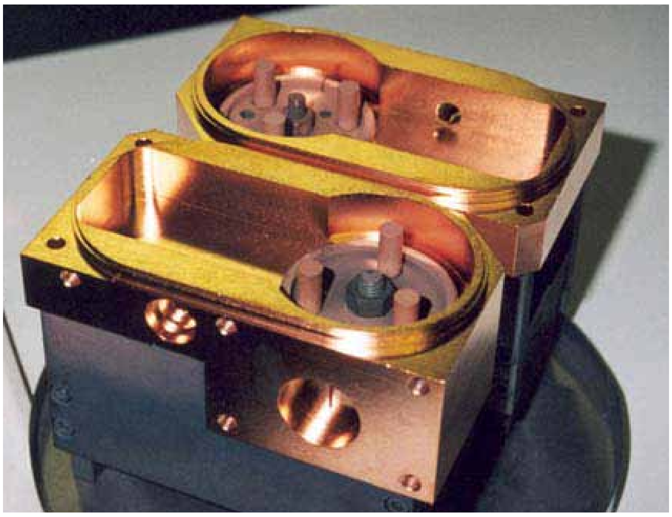

Figure 3. An assembly jigged ready for vacuum step brazing

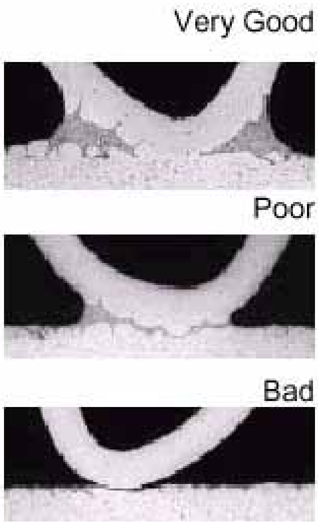


Figure 4. Good and bad joints in an aluminium automotive radiator core

Figure 5. A typical aluminium brazing furnace

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